OZONE-DEPLETING REFRIGERANT REPLACEMENT – Case Study

Location: Fermilab **Contact:** Steve Krstulovich (708) 840-3127

Process: Convert several comfort cooling chillers from R-502 to R-134a
Convert Linear Accelerator (LINEX) system to R-123

The Facility: The Fermi National Accelerator Laboratory (Fermilab) is a National Laboratory under the U.S. Department of Energy (DOE). Fermilab is a high-energy physics laboratory, home of the world's most powerful particle accelerator, the Tevatron. Scientists from across the U.S. and around the world use Fermi's resources in experiments to explore the most fundamental particles and forces of nature.

Background:
In 1991, staff at Fermilab began investigating the replacement of their large cooling equipment which used ozone-depleting chlorofluorocarbons (CFCs) as the working fluid. When Fermilab started this project, they had several large chillers which were approximately 20 years old. As such, the chiller replacement program was fueled by the need to upgrade old equipment which was nearing the end of its useful life, and to realize energy savings. Aware of the requirements and production phaseout schedules for CFCs established under the Clean Air Act amendments of 1990, the chiller replacement team at enacted measures to ensure that the new equipment would not use CFCs.

The Fermilab team that was brought together to work on this project included staff from environmental safety and health, operations, and engineering. To ensure that new equipment would not use CFCs, or other ozone-depleting substances (ODSs) as their working fluid, the team also enacted site policies restricting new purchases of equipment that uses ODSs. This would help ensure a longer useful, cost-effective lifetime of the new equipment.

Approach:
To identify chillers that need to be replaced, the chiller replacement team conducted a site-wide equipment survey. This survey was also used to re-evaluate the required heating and cooling loads at the site. In several cases, process cooling was accomplished by using the same equipment used for comfort cooling applications. The team looked at ways to uncouple the process and comfort cooling systems thereby allowing more control for each process. This approach allowed them to re-examine the existing chiller capacities to determine if they could reduce the capacity of the replacement chiller and thereby save energy and money.

In addition to separating the process and comfort cooling applications, the team also examined other ways in which chiller capacity could be reduced and energy saved. Using approaches developed by the U.S. Department of Energy's In-House Energy Management (IHEM) Office, the Fermi team also reviewed existing lighting requirement to determine if lighting upgrades would assist in returning energy savings and reducing chiller capacity requirements. In conjunction with the chiller replacement program, significant lighting upgrades were also made.

The decision on which equipment to replace first was based, in most cases, on anticipated energy savings. The LINEX is considered a critical system, and therefore was targeted for replacement early in the process. For the LINEX chiller, the team examined both R-134a and R-123. The contractor operating this system was given credit for reductions in energy. The replacement team used the life-cycle cost approach developed by IHEM. This approach requires calculation of the energy reduction as well as estimated time for investment payback.

Funding: Because the systems had exceeded their useful life, Fermi was able to secure funding from IHEM. IHEM provides assistance in funding projects which will result in real energy savings. After conversion of the LINEX system from R-11 to R-123, the chiller COP was reduced from .8 to .5. The estimated payback period for the chiller based on energy savings is 7 years.

Accomplishments: To date, Fermi has replaced two thirds of the existing chillers. Large chillers were initially targeted for replacement. These chillers were converted from R-502 to non-ozone-depleting R-134a. Smaller equipment was converted to SUVAs MP30, 69 (confirm). The LINEX system was converted from R-11 to R-123.

Special Considerations: The LINEX system is used to cool the main accelerator ring. Because it uses ionized water, special stainless steel barrels had to be custom built for the new chiller. This system was originally run off the comfort cooling system. This had the effect of increasing the demand on the HVAC system when the accelerator was in use. When the system was converted, it was un-coupled from the HVAC system. In addition to energy savings from the use of newer, more energy efficient equipment, the LINEX has also realized efficiency savings by having more direct control of the cooling process, and decreased maintenance requirements. The comfort system to which the LINEX was attached is on line to be the next replacement. This system still carries some process loads, but these loads will be removed when the system is converted.

The Future: Fermi has submitted another IHEM energy savings performance contract to cover conversion of the remaining chillers. The target date to have all chiller equipment replaced/retrofitted is 1998. The site is currently targeting their smaller R-11 comfort cooling systems for replacement and/or retrofit.

Excess ODSs: Because of their significant progress in replacing existing equipment, Fermi anticipates having thousands of pounds of excess R-11 that will not be needed for site activities. Fermi is very interested in exchanging information with other DOE sites to facilitate the sale of this excess to other DOE facilities that may still need this refrigerant.

Lessons Learned:
Because Fermi was proactive in replacing old equipment, the replacement team did not face significant delays in obtaining replacement equipment. Delays in being able to obtain replacement chillers is currently anticipated to be several months, depending on the complexity of the replacement and the amount of custom work required. Fermi has found that replacement equipment is significantly more energy efficient than existing equipment, and requires less maintenance.

The chiller replacement at Fermi is a good example of how such replacements should be approached. Fermi had completed and inventory and prioritized the replacement needs. The Fermi team worked with equipment manufacturers to identify replacements that met the energy efficiency requirements that they needed to obtain IHEM funding. In addition, the Fermi team did not address chiller replacement as a stand-alone issue. They also examined the required cooling load that the new system would have to meet, and examined other retrofits (such as lighting) that could positively affect the energy savings resulting from the chiller replacement.

Because the LINEX is a critical system, the chiller replacement was planned for a time when additional work required that the system be shut down. This caused minimal disruption in the work being done. The planned conversion of the HVAC system to which the LINEX was originally connected is also being scheduled for a time when other building retrofit activities are scheduled and the shutdown will not cause significant disruption in activities.

Some additional changes were required following some chiller replacements. Of the 48 small systems that have been converted, 6 had problems with frosting on the coils as a result of increased efficiency. Staff at Fermilab also found that replacing smaller equipment, such as food systems, was more difficult than larger chillers.